UNIVERSITY OF MAINE

The Maine Agricultural Experiment Station

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THE MEXICAN BEAN BEETLE IN MAINE

EGGS OF MEXICAN BEAN BEETLE

UNIVERSITY OF MAINE

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[1] Collaborator.

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BULLETIN 431

THE MEXICAN BEAN BEETLE IN MAINE

JOHN H. HAWKINS

Since the Mexican bean beetle is established in all the important bean growing areas of Maine, its recognition and control are important in the production of beans needed as wartime food, and in limiting spread and increasingly greater injury to future bean crops. This bulletin is written with the intent of giving immediate help to those seeking help in problems of recognition and control of the Mexican bean beetle. It is not a detailed report and applies only to conditions as they exist in Maine. Work on the problem is being continued and more extensive and technical reports are planned for future publications.

ORIGIN AND SPREAD

The Mexican bean beetle probably originated in Mexico. It was reported from southwestern United States in 1864, Douglass, (1933).[1] From there the spread eastward has been gradual and it was 1930 when it was found in southwestern Maine. Now it is present in all the principal bean growing areas of the State.

IMPORTANCE

The Mexican bean beetle is the most destructive insect affecting beans in Maine. The bean crop as a whole is never entirely free from infestation. Sometimes a large portion of the bean crop is severely injured and there remains the possibility that this pest may become an even greater menace to the bean crop of the State. As it now stands losses of several thousands of dollars annually are caused by this insect to the bean crop of Maine.

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[1] See list of literature cited.

THE MEXICAN BEAN BEETLE AND OTHER LADYBIRD BEETLES

The Mexican bean beetle belongs to the ladybird beetle family Coccinellidae. Many of the ladybird beetles are beneficial and destroy large numbers of injurious insects, especially aphids which feed on our field, garden, and orchard crops. The only ladybird beetle known to be injurious to crops in Maine is the Mexican bean beetle which can be distinguished by the form of the body, the arrangement of spots on the wing covers and by the type of injury caused to bean plants (Figs. 8, 9, and 10).

DESCRIPTION OF THE MEXICAN BEAN BEETLE

There is some variation in the size of the adult Mexican bean beetle but the length is usually a little more than ¼ of an inch and the width is about ¾ that of the length. In shape and size the beetles are about equal to half of a large pea, being rounded above and flattened below (Figs. 1, 2, 3, and 4). The general color is yellowish for newly emerged beetles and coppery bronze for the older ones. The hard elytra or outer wing covers protect the thin inner wings folded beneath, which are unfolded and spread out when the beetles fly. Black spots, roughly round in outline, are arranged in three rows across the wing covers (Fig. 4). The first row back of the head consists of a series of six spots arranged in a zigzag pattern across the beetle's back. The next or middle row of six spots is arranged more nearly in a straight line and the last row of four spots is arranged roughly to form a crescent. These 16 spots differ in their arrangement from that of any of the beneficial ladybird beetles found in Maine. The downward thrust head (a, Fig. 1) and the two eyes which appear as small black spots can be seen by looking closely at the front of the head. The mouth appendages, including the cutting jaws, or mandibles (Mb, Fig. 2), can be seen at the underside of the head only by close examination or through magnification. On the upper side of the body between the head and wing covers is the yellowish thoracic shield (b, Fig. 2). The yellowish color, the lack of spots or markings on the thoracic shield, and the 16 spots and their arrangement on the wing covers are characteristic of the Mexican bean beetle and serve to separate

it from our common large 15 spotted beneficial ladybird beetle for which the Mexican bean beetle is sometimes mistaken.

FIG. 1

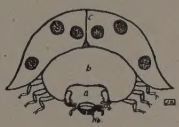

FIG. 2

FIG. 1. Lateral view of the Mexican bean beetle. A. Head. B. Thoracic shield. C. Elytra or wing covers. (Actual length about ¼ inch.)

FIG. 2. Front view of the Mexican bean beetle, enlarged. Actual width of the beetle about 3/16 of an inch. A. Head. B. Thoracic shield. C. Elytra or wing covers. Mb. Mandibles or jaws.

FIG. 3. Mexican bean beetles on under side of a bean leaf. Slightly enlarged. Actual size of the beetles about ¼ inch in length.

EGGS OF THE MEXICAN BEAN BEETLE

Eggs of the Mexican bean beetle (Fig. 5) are elongate oval in shape, yellowish in color, about 1/20 of an inch in length, and they are about ½ as wide as they are long. Eggs are laid in groups of

FIG. 4. The Mexican bean beetle from above, enlarged. The actual size being about ¼ inch in length. A. Head. B. Thoracic shield. C. Wing covers or elytra.

45 or 50 and are attached by one end to the underneath side of the bean leaf.

FIG. 5. Eggs of the Mexican bean beetle seen from above, attached to under side of a bean leaf. Slightly enlarged from natural size of about 1/20 inch in length. (*Photographed by Dr. E. C. Ogden.*)

LARVAE OF THE MEXICAN BEAN BEETLE

The larvae of the Mexican bean beetle are quite small when first hatched but often attain a length of ⅓ of an inch when fully

FIG. 6. Two larvae and a pupa of the Mexican bean beetle. About natural size.

FIG. 7. Pupae of Mexican bean beetle, (P), empty pupal skins from which the beetles have emerged, (PC), and 3 adult beetles, (A).

mature (Fig. 6). The young larvae appear to be quite black in color due to the many black branched spines which cover all but the head and ventral or lower portion of the body. In the older larvae the spines are pale and the yellowish color predominates.

PUPAE OF THE MEXICAN BEAN BEETLE

Pupae of the Mexican bean beetle (Fig. 7) are attached by the last larval skin to the undersides of the bean leaves. They are yellowish in color, are a little more robust, and otherwise about the same size and shape as the beetles. The greyish cast skins, the bright yellowish bodies, and their lack of activity serve to identify pupae.

BIOLOGY AND LIFE HISTORY OF THE MEXICAN BEAN BEETLE

When the weather is warm early in the season it enables the Mexican bean beetle to break its hibernation period and the beetles appear on early planted beans about the first of June. An early spring combined with a late fall and warm weather prolongs the season of injury by the larvae and adults. It was during such a season in 1942 that the Mexican bean beetle caused the most extensive injury to beans ever recorded for central Maine.

When snow coverage is ample, the beetles are relatively safe in their hibernating quarters beneath the snow and surface debris, temperatures at this level being several degrees above and more constant than that of the surrounding air. It is, therefore, entirely possible that Mexican bean beetles, hibernating beneath the snow here, are less subject to low and changing temperatures than they are farther south where the soil is often bare during the winter months. Ample snow coverage is probably one reason why the Mexican bean beetle has been able to increase in this area during the last decade.

Mexican bean beetles can successfully hibernate only as adults. They are said to prefer a mixed oak and pine environment in other sections of the country, Howard (1936), where they seek cover for the winter beneath a blanket of debris of pine needles and oak leaves. Under climatic conditions of Maine many of

the beetles fail to reach a forest environment and when overtaken by cold weather find refuge beneath bean stacks and other refuse in the fields. Regardless of where they hibernate, the adult beetles have been known to appear in central Maine early in June when the weather was warm and about 10 to 14 days later when the weather was cooler. The beetles are able to fly considerable distances, consequently beans several miles distant from the winter quarters may be infested. June 2 is the earliest date of injury by the Mexican bean beetle recorded for central Maine.

Since the beetles arrive intermittingly in bean plantings the adult beetles, eggs, and larvae are all present during the greater part of the summer season. Eggs are laid shortly after the first appearance of the beetles which is sometimes as early as the first week in June. The eggs hatch in less than two weeks. The young or larvae reach their maturity by four successive steps, or instars, after each of which they shed their skins. The larval stage of the Mexican bean beetles is the stage in which much active feeding occurs and during which most of the damage is done to beans. The larvae feed for about three weeks after which they molt and change to pupae.

The inactive resting or pupal stage (Fig. 7) occurs at the end of the larval stage, and occupies about 20 days during which the transformation from larva to adult takes place. At the end of the pupal stage the beetles emerge, feed a while and either mate and lay eggs for a late summer generation or spread for winter hibernation. During 1943 the late summer generation eggs were laid about the first of September. Eggs are laid from early June until freezing weather and from eggs to adult requires a total time period of about 40 days during average Maine summer temperatures, the time varying with weather conditions and, in general, the life history is shorter coincident with high temperatures. When there is a late summer generation of larvae, a few are able to reach the beetle stage, but a great many never get beyond the pupal stage, are caught by freezing weather and perish. The old coppery bronze beetles of the previous hibernating winter die before the first of September so that the current new summer generation of freshly emerged bright yellowish beetles are easy to distinguish as the hibernating, overwintering generation.

INJURY CAUSED TO BEANS BY ADULT MEXICAN BEAN BEETLES

When warm weather comes early, adult Mexican bean beetles break hibernation and are ready to start feeding on beans soon after the plants come up. Attack by the beetles early in June before the young bean plants have become well established may seriously affect the stand. Injury to the bean plants caused by the adults results in a lace-like appearance to the foliage in which large holes appear (Figs. 8 and 9). Early infestations result in the early laying of eggs from which larvae will hatch and continue the destruction started by the adults.

FIG. 8. Bean plants injured by larvae and adults of the Mexican bean beetle showing the leaves from which the green portions have been eaten giving the plants their lace-like appearance.

FIG. 9. Bean plant showing how individual bean plants are injured by adults and larvae of the Mexican bean beetle. Few pods are formed on the plant and those formed do not yield normal sized beans.

INJURY CAUSED BY LARVAE OF THE MEXICAN BEAN BEETLE

Larval feeding by the Mexican bean beetle begins about two weeks after the first appearance of the adult beetles and

before the beetles have ceased feeding. The larvae feed on the underneath sides of the leaves. The tissue is eaten away in parallel strips separated by narrow, irregular lines of uneaten tissue and the thin upper layer of the upper epidermis is left

FIG. 10. Under side of bean leaf showing how the larvae of the Mexican bean beetle eat away most of the green portions of the leaf leaving narrow parallel strips of the green portion separating the transparent epidermis. In case of severe injury the leaves deteriorate and the bean plants are denuded of foliage.

nearly intact (Fig. 10). Badly injured plants do not develop fully and the bean yield is often seriously affected. The larvae are responsible for the greater portion of the injury caused by the insect to the beans during the period of July to October.

HOST PLANTS

The Mexican bean beetles feed upon several kinds of beans and some wild host plants. The common bush variety of garden and canning beans, pole beans, kidney beans, field beans such as the yellow eye and pea beans, and lima beans grown in Maine are all subject to injury. Observations show that the runner or semi-runner type of field beans and pole beans offer conditions especially favorable to infestation by the beetles and their larvae. Bush types of beans are also injured and because they are the predominant type of beans grown in the gardens and fields of the State, extensive injury is done to them by the Mexican bean beetle. The beggarweed or beggar-tick (*Meibomia* sp.) and the soybean although not reported as hosts in Maine are infested by the Mexican bean beetle in other states.

EFFECT OF HEAVY FOLIAGE AND SPACING OF BEAN PLANTS

In general the heavier the foliage the more likely conditions are to be favorable to habitation by Mexican bean beetles and their larvae. Heavy bean foliage is difficult to treat when it becomes necessary to apply insecticides to the bean plants.

It was found that a 3-inch interval was a good planting distance for beans, Burgess and Bailey (1938) and Burgess (1941). Turner and Friend (1935) found that sprayed bean plants were injured less by the Mexican bean beetle as the space between plants was increased and that there was only ½ the rate of reduction in yield when the beans were planted 6 to 8 inches apart than when the spacing was 2 inches. The same authors found that there were twice as many eggs of the Mexican bean beetle present on 100 bean plants spaced 2 inches apart as there were when the same number of plants were planted 8 inches apart. Probably the best spacing for beans where this insect is a factor

would be to plan to have the plants stand so that there were 3 or 4 to the foot or at 3- or 4-inch intervals.

INSECTICIDES FOR MEXICAN BEAN BEETLE CONTROL

Insecticides can be used effectively in control of the Mexican bean beetle. Insecticides should be purchased well ahead of the time when they are to be used and their choice made on the basis of their (1) cost, (2) effectiveness, (3) effect on the bean yield, (4) kind of machinery available for their application, and (5) with consideration for the safety of the ultimate consumer.

Three insecticidal materials used over a period of years in central Maine have proven satisfactory for Mexican bean beetle control. These materials are calcium arsenate, cryolite, and rotenone.

CALCIUM ARSENATE

Calcium arsenate is relatively inexpensive and under most conditions readily purchased from local insecticide dealers. Calcium arsenate is recommended especially for beans early in the season before the pods are set on the plants and for dry shelled beans or when the immature beans are removed from the pods to be canned, eaten or marketed as fresh shell beans. Where beans grown for canning have been protected from the time the first Mexican bean beetles appear until the pods are set on the plants, the control will be effective until the beans can be harvested. (See warning, p. 218.)

Calcium arsenate can be used with good results on beans *only when combined with magnesium hydrated spray lime* regardless of whether the material is to be applied in the form of a dust or a spray.[2] Since magnesium lime may not be stocked by local stores arrangements for securing it should be made in advance of its use. Dust containing calcium arsenate and magnesium lime cannot be purchased ready mixed. Mixing can readily be done at home which insures a fresh supply of an effective insecticide. (County Agents, Extension Service or Experiment Station will furnish mixing directions for those desiring them.)

[2] Lime, approximately 30% magnesium expressed as magnesium oxide.

The following formulae are recommended:

DRY DUSTS

1. Calcium arsenate ..... 1 part
   Copper lime dust (to be made of monohydrated copper sulfate 1 part and hydrated magnesium spray lime 4 parts) ..... 9 parts
2. Calcium arsenate ..... 1 part
   Hydrated magnesium spray lime ..... 9 parts

Dusts 1 and 2 can be made up in any amounts as long as the above proportions are adhered to. (Dust mixtures containing monohydrated copper sulfate are likely to become extremely lumpy if held over from one season to another.)

WATER SPRAYS

3. Calcium arsenate ..... 3 pounds
   Copper sulfate (blue vitriol) ..... 10 pounds
   Hydrated magnesium spray lime ..... 10 pounds
   Water ..... 100 gallons

   For small amounts use:

   Calcium arsenate ..... 3 level tablespoonfuls
   Copper sulfate ..... 9 level tablespoonfuls
   Magnesium hydrated lime ..... 9 level tablespoonfuls
   Water ..... 1 gallon
4. Calcium arsenate ..... 3 pounds
   Hydrated magnesium spray lime ..... 3 pounds
   Water ..... 100 gallons

   Or for small amounts

   Calcium arsenate ..... 3 level tablespoonfuls
   Hydrated magnesium spray lime ..... 3 level tablespoonfuls
   Water ..... 1 gallon

Cryolite is effective in the control of the Mexican bean beetle. It is toxic to humans and domestic animals and it should be used with care (see warning, p. 218). Cryolite is now stocked by insecticide dealers in Maine and can be ordered through local dealers. It is used as follows:

DUST

5. Cryolite ..... 1 part
   Talc, clay, or flour ..... 3 parts

SPRAY

6. Use according to directions on the package or

   Cryolite ..... 3 pounds
   Water ..... 100 gallons

   Or for small amount

   Cryolite ..... 3 level tablespoonfuls
   Water ..... 1 gallon

Warning: Beans treated with calcium arsenate or cryolite after pods are formed on the plants should not be used as food unless it is certain that harmful residues have been removed. Bean refuse treated with insecticides should not be fed to livestock where there is danger of poisoning.

Lead arsenate or Paris green should not be applied to beans as their use is likely to result in a reduction in yield, and they are also poisonous to human beings.

ROTENONE

Rotenone is not injurious to humans or domestic animals when used according to directions. It is often used on beans when it is necessary to treat them after the pods are set on the plants. Rotenone has in the past been available in large quantities but now its production has become restricted and it is more costly than formerly. Rotenone is obtained from certain tropical plants and ground derris and cubé roots are two common materials containing rotenone. The ground root is commonly used in water suspensions as a spray and with diluents as dust. Recommendations follow.

DUST

1. Rotenone dust prepared by the manufacturer and used according to directions on the package.

*2. Homemade rotenone dust
Ground derris or cubé root
(4 per cent rotenone) ..... 12½ pounds
Talc, clay, pyrophyllite or sulfur ..... 87½ pounds

*Or for small amounts

Ground derris or cubé root
(4 per cent rotenone) ..... 3 level tablespoonfuls
Talc, clay, pyrophyllite or sulfur .... 1 pound

*1. Ground derris or cubé root
(4 per cent rotenone) ..... 3 pounds
Water ..... 100 gallons

*Or for small amounts

*2. Ground derris or cubé root
(4 per cent rotenone) ..... 3 level tablespoonfuls
Water ..... 1 gallon

3. Rotenone spray materials prepared by the manufacturer and used according to the directions on the package.

THE AMOUNT OF INSECTICIDES REQUIRED

About 100 gallons of spray material is necessary to treat one acre of beans. One gallon of spray will effectively cover a row of beans about 125 feet long. These amounts will vary considerably with the age and size of the bean plants. Careful adjustment of spray machinery will often save a considerable amount of insecticide.

About 35 pounds of insecticide in dust form will treat an acre if the dusting machinery is adequate to the job and properly adjusted. A pound of dust will treat effectively a 500 foot row of beans. Dusts are somewhat more expensive in cost but require less labor in application than do spray materials. In general where hand apparatus only is available it is easier to penetrate

* Ground derris or cubé root containing 4 per cent or more of rotenone may not be available at present. These recommendations are included with the thought of using such supplies as are available now or when the situation regarding the rotenone supply is improved.

dense bean foliage with insecticides in dust form than where water sprays are used with the material. Where farmers are already equipped with potato dusters or sprayers, these machines can be adapted to Mexican bean beetle control by slight changes and small expense.

APPLICATION OF INSECTICIDES FOR MEXICAN BEAN BEETLE CONTROL

The effectiveness of the insecticides recommended for the control of the Mexican bean beetle depends to a large extent upon timing of their application to coincide with the feeding period of the insects, and their application in such a manner that the undersides of the bean foliage is protected at all times during the active feeding period of the beetles and their larvae.

The feeding by the adults on young plants is sometimes severe and the application of insecticides early in the season may save the crop and make late season applications unnecessary. If early infestations are not noticed it is a good plan to apply insecticides at about the time the young larvae are hatching but before serious injury is caused. Later applications are necessary if the infestation is not noticed until after the larvae have become large and injury to the bean plants has become extensive. When the pupal stage of the Mexican bean beetle is reached it is then too late to apply insecticides. It is then better to try to harvest the beans and plow under the crop while the inactive pupae are still attached to the plants.

Insecticides in dust form are most effective if applied when the air is relatively still and when there is some moisture on the leaves. Early morning is a good time for dusting but when there is danger of spreading bean diseases, the dusts can be applied during the evening at about the time dew is beginning to be formed on the bean plants. Dusts used in Mexican bean beetle control are most effective when they are not subject to rainfall for at least a few hours after their application.

Three applications of the insecticides recommended for the control of the Mexican bean beetle are sufficient to control the heaviest of infestations under Maine conditions, providing that the insecticides are applied thoroughly under the proper condi-

tions. Sometimes it may be necessary to treat all the beans in a given field or garden. Sometimes the infestations are in small isolated areas which can be controlled by spot dusting or spraying. In cases of light infestation the Mexican bean beetle can be controlled by less than three insecticidal treatments. The larvae should in any case be destroyed and not allowed to mature and move from injured bean plantings to other beans or to winter hibernating quarters.

Thoroughness in applying insecticides for the control of the Mexican bean beetle depends upon the proper adjustment and use of machinery. Each grower will need to adjust his duster or sprayer according to the size of the bean plants, the density of the bean foliage and so that the underneath sides of the leaves are treated. In general, nozzles of the machines will need to be turned slightly upward (see figures 11, 16, 18, 22, and 24), and in cases where more than one row is to be treated at a time, adjustment to row width may be necessary.

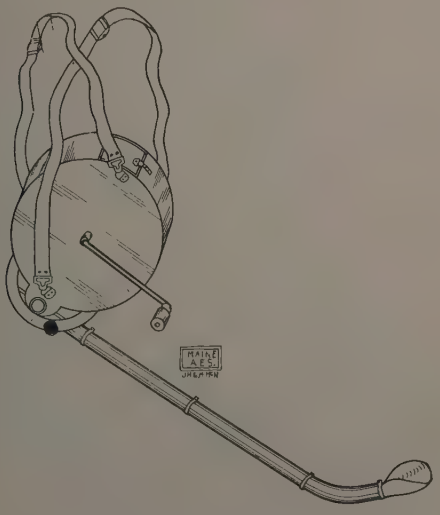

FIG. 11. Rotary type hand duster with nozzle turned up to distribute dust to lower surfaces of bean foliage.

Some of the canning companies of the State have furnished growers with small rotary-type hand-operated dusters for applying insecticides to the beans (Figs. 11 and 12), which have been used for spot dusting of small isolated infestations of the Mexican bean beetle in larger plantings of beans. This type of duster is useful for the gardener or where not more than one fourth of an acre is to be treated. The small plunger type of duster (Fig. 13) is suitable for the treatment of a few feet of row or a few hills of beans. Traction driven row crop or potato dusters (Fig. 14) can be used for treating small fields of beans when the nozzles are properly adjusted. Power-driven dusters (Fig. 15) of the type owned by some of the canning companies and by some potato growers are suitable machines for applying dusts for control of the Mexican bean beetle. These dusters should be equipped with row crop nozzles which can be adjusted, or with special bean beetle nozzles (Fig. 16).

FIG. 12. Another rotary type duster. The fan-shaped delivery nozzle on this duster can be turned upward for proper delivery of the dust to under sides of the bean leaves. (*Courtesy Niagara Sprayer and Chemical Co.*)

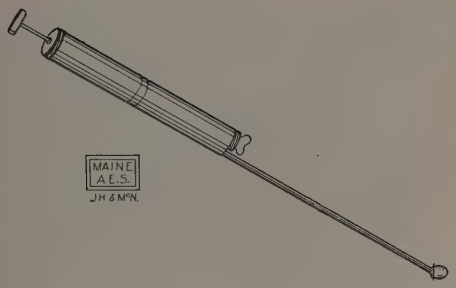

FIG. 13. Small hand duster suitable for use in control of the Mexican bean beetle in small gardens (note that adjustment of delivery bulb is so that dust is distributed upward).

FIG. 14. Horse-drawn traction-driven duster. Many of these dusters are used in Maine for dusting of potatoes. These dusters can be used effectively in control of the Mexican bean beetle by adjusting the nozzles to deliver the dust upward. (*Courtesy Maine Extension Service.*)

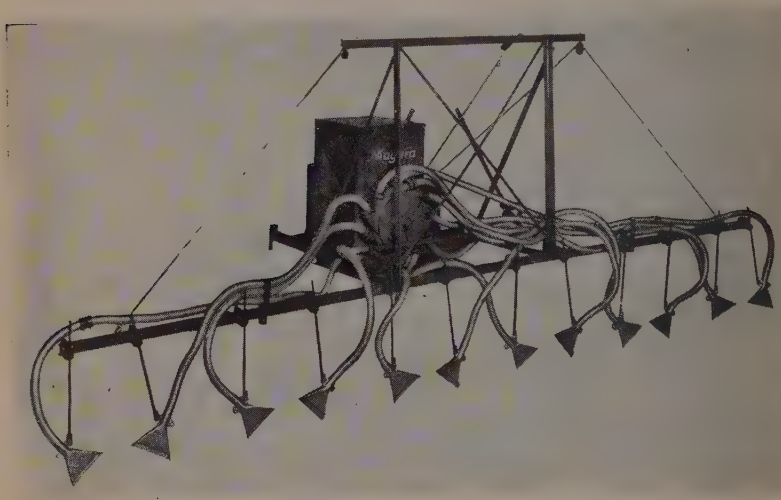

FIG. 15. A large power take-off duster equipped with row crop nozzles which can be adjusted to deliver the dust to under sides of bean leaves for control of the Mexican bean beetle. This type of duster is attached directly to the tractor. (*Courtesy Niagara Sprayer and Chemical Co.*)

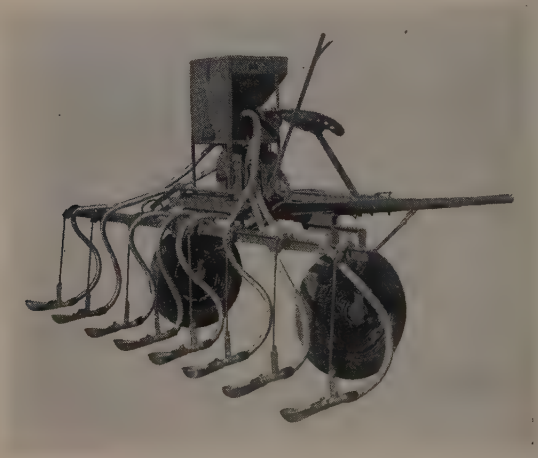

FIG. 16. An engine driven duster equipped with horse hitch. Notice the cup-shaped, turned up bean beetle nozzles on this duster. (*Courtesy Niagara Sprayer and Chemical Co.*)

The ordinary equipment for applying insecticides on many small farms is the traction-driven potato sprayer (Fig. 17) which

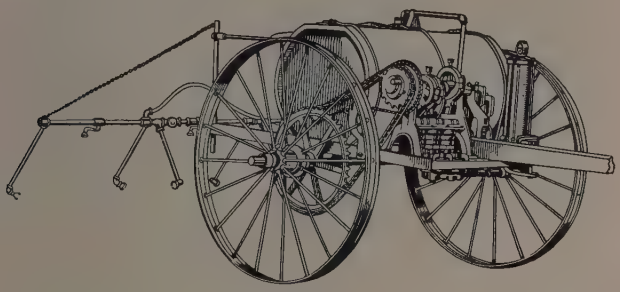

FIG. 17. A horse-drawn, traction-driven sprayer which can be used effectively by turning the nozzles upward. (*Courtesy John Bean Mfg. Co.*)

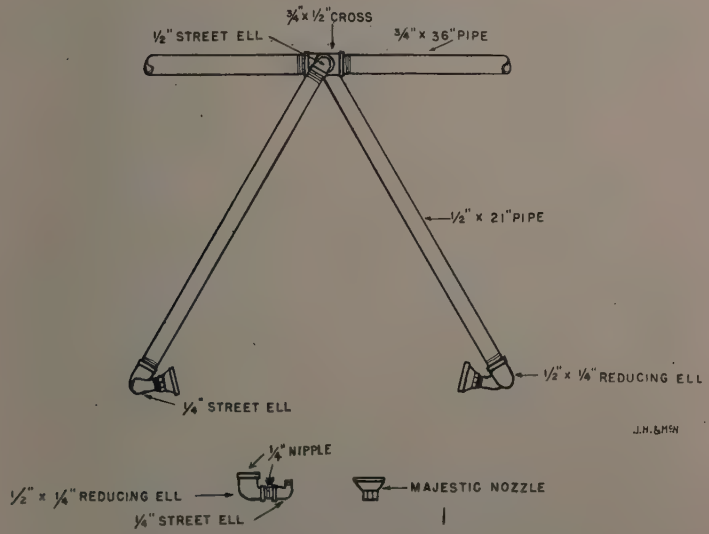

FIG. 18. Detailed drawing of nozzle arrangement for a spray boom found suitable for applying insecticides for Mexican bean beetle control. The nozzles on this boom can be adjusted to the proper angle and height for effective application of the spray. The nozzles can also be used as shown in Figure 19, one of each pair being used for a given row.

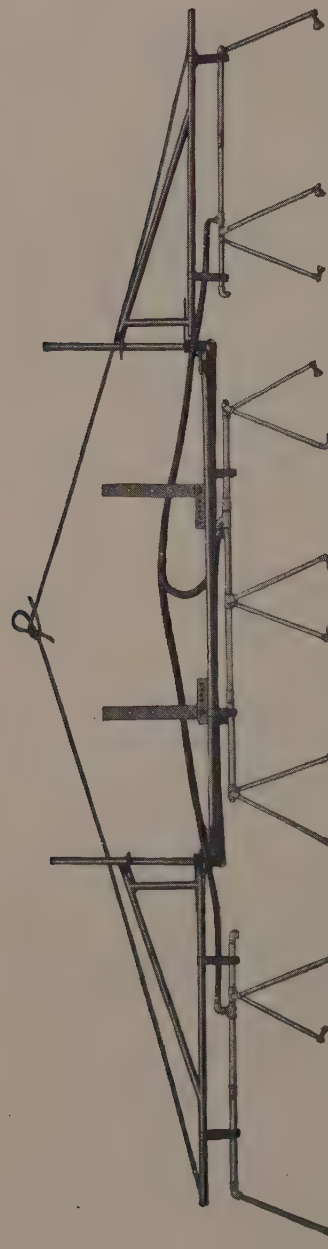

FIG. 19. A six row spray boom using a different nozzle arrangement than that shown in Figure 18. Bean rows would come in the large open spaces between nozzles and the nozzles would need to be turned slightly more upward for spraying of beans than is shown in this figure. (*Courtesy John Bean Mfg. Co.*)

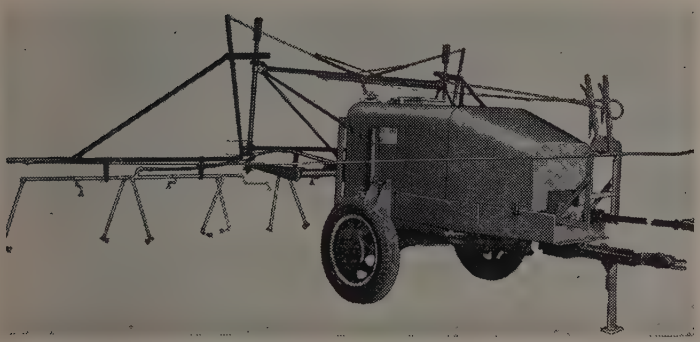

FIG. 20. A power take-off sprayer with boom adjustable for height and angle suitable for spraying beans in Mexican bean beetle control. (*Courtesy John Bean Mfg. Co.*)

FIG. 21. An 8-row sprayer mounted on a tractor with power take-off attachment which could be used in Mexican bean beetle control with minor adjustments. (*Courtesy Maine Extension Service.*)

can be used by making nozzle adjustments similar to Figures 18 and 19. Large power-driven potato sprayers (Figs. 20 and 21) can also be used effectively in Mexican bean beetle control where there are large acreages to be covered and they can be properly adjusted. The 2 to 5 gallon cylinder type sprayer (Fig. 22) and the plunger type hand-operated sprayers (Fig. 23) can be used for spot treatment of small isolated areas where the Mexican bean beetle has become established in larger plantings of beans or

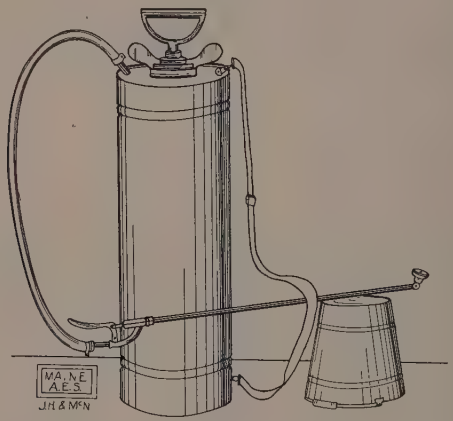

FIG. 22. A cylinder type, compressed air hand-operated sprayer suitable for control of the Mexican bean beetle on small plantings.

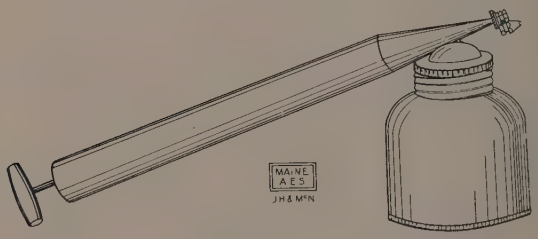

FIG. 23. A small plunger type hand sprayer suitable for the application of insecticides for the control of the Mexican bean beetle only on very small plantings or for spot treatments.

where gardens or small bean patches are to be treated. The knapsack sprayer (Fig. 24) is effective and convenient to use in small gardens and small infested spots in larger plantings. The wheelbarrow sprayer (Fig. 25) is of many types and can be used economically where the area to be treated is not greater than about ¼ acre. Some of the wheelbarrow type sprayers have air chambers

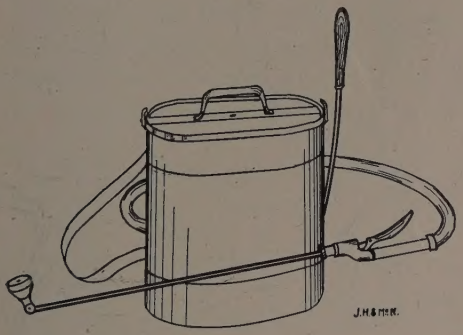

FIG. 24. A knapsack sprayer with nozzle turned upward. This type sprayer is useful for home or small market gardener in Mexican bean beetle control.

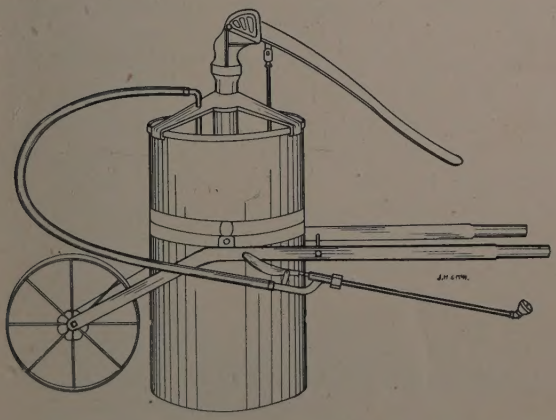

FIG. 25. A wheelbarrow sprayer can be used in the application of insecticides to small bean plantings but is not suitable for large field operations in Mexican bean beetle control.

and some are equipped with small gas engines or electric motors. In general wheelbarrow sprayers are more expensive and more efficient than the smaller hand-operated cylinder knapsack and bucket sprayers. The small hand-operated bucket type sprayer (Fig. 26) is cheap and satisfactory for treating of small bean plantings. There are many other types of dusters and sprayers which cannot be described here for lack of space.

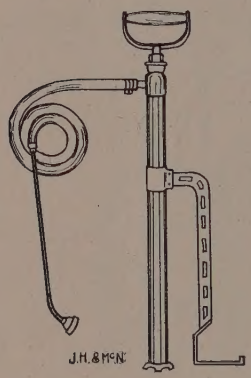

FIG. 26. Bucket or stirrup spray pump. This pump is operated by placing the cylinder in a pail, holding it with the bracket foot piece or stirrup on the outside of the pail and operating the plunger by hand.

TIME OF PLANTING TO ESCAPE EARLY INFESTATION

It is sometimes advisable to plant beans during the period from June 1 to June 12, depending upon the progress of the season. Thus early spring beetle injury is avoided because bean plants are not up until after most of the first flight of beetles has passed. The beetles are then forced to seek other areas in which to lay their eggs for the summer generation. Beans may become infested at any time from June to September but ordinarily the later flights of beetles are not so destructive as the flights occurring during the first few days of June, although the larvae are destructive at all times.

RELATION OF WEEDS IN THE BEAN FIELD TO MEXICAN BEAN BEETLE INJURY

Weeds and grass allowed to grow among the beans favor the Mexican bean beetle by furnishing shelter and breeding places. Weeds among the beans also multiply the difficulty of applying

the insecticides and so weaken the bean plants that they are especially susceptible to the attacks of the beetles and larvae. The judicious use of fertilizer also increases the resistance of the bean plants to attacks by this insect.

PLOWING UNDER BEAN PLANTS AFTER HARVEST

It is a good plan to carefully plow under bean plants soon after the beans are harvested. Plowing during late July and early August will destroy many of the larvae, the inactive pupae and the comparatively helpless beetles when they first emerge.

THE VALUE OF CLEANING UP PLANT REFUSE IN MEXICAN BEAN BEETLE CONTROL

There is danger that beetles may hibernate beneath grass, bean stacks, weeds, and refuse in or near the bean field and it is a good plan to see that these hibernating advantages are removed. Plowing under of such refuse is especially recommended wherever it can possibly be done. Cleaning up or removal of old stone walls and hedge rows is also advisable. The burning over of weedy or grassy areas is doubtless of some value when our fall weather conditions are such that it can be thoroughly done. Burning over of such areas during early spring would be of value in destroying any beetles which might be present at that time.

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